CEOS Atmospheric Composition Constellation Meeting
(ACC-11)

Early Results from the NASA Orbiting Carbon Observatory-2 (OCO-2)

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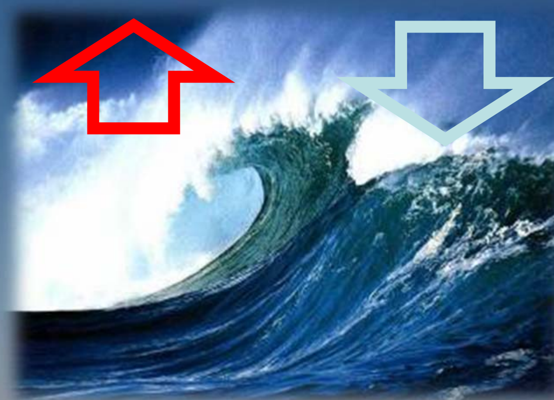
What Controls Atmospheric Carbon Dioxide?

Natural systems including the ocean and plants on land both absorb and emit CO_2 to the atmosphere

- Each year, the Land Biosphere
  - emits ~120 Billion tons carbon (~440 Gt CO_2)
  - reabsorbs ~122 Billion tons carbon (~450 Gt CO_2)
- Each year, the Ocean
  - emits ~90 Billion tons carbon (~330 Gt CO_2)
  - reabsorbs ~92 billion tons carbon (~340 Gt CO_2)



Currently, these natural systems are

- absorbing more than half of the 40 Gt of carbon dioxide emitted by human activities
- limiting the rate of carbon dioxide buildup and its impact on the Earth's climate

A Perfect Ride into Space


Credit: Bill Ingalls, NASA

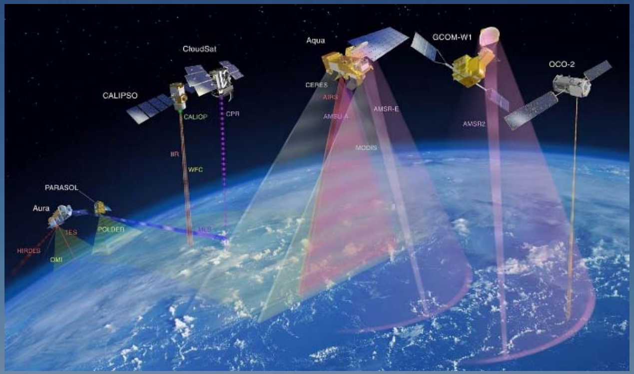
Lift-off at 2:56 am PDT, 02 July 2014


Credit: Jeff Sullivan


Credit: Jeff Sullivan

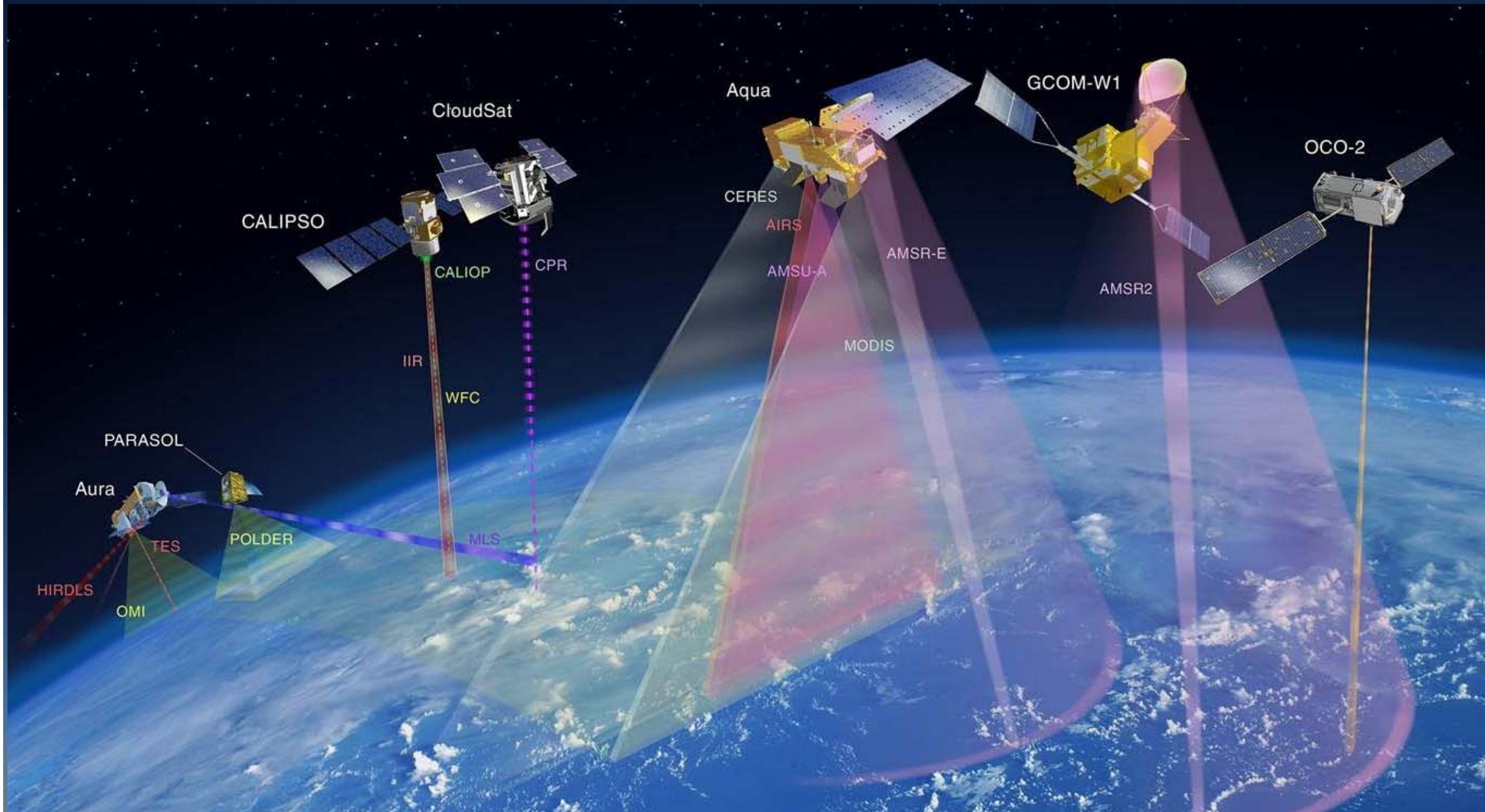

Credit: NASA

Separation!



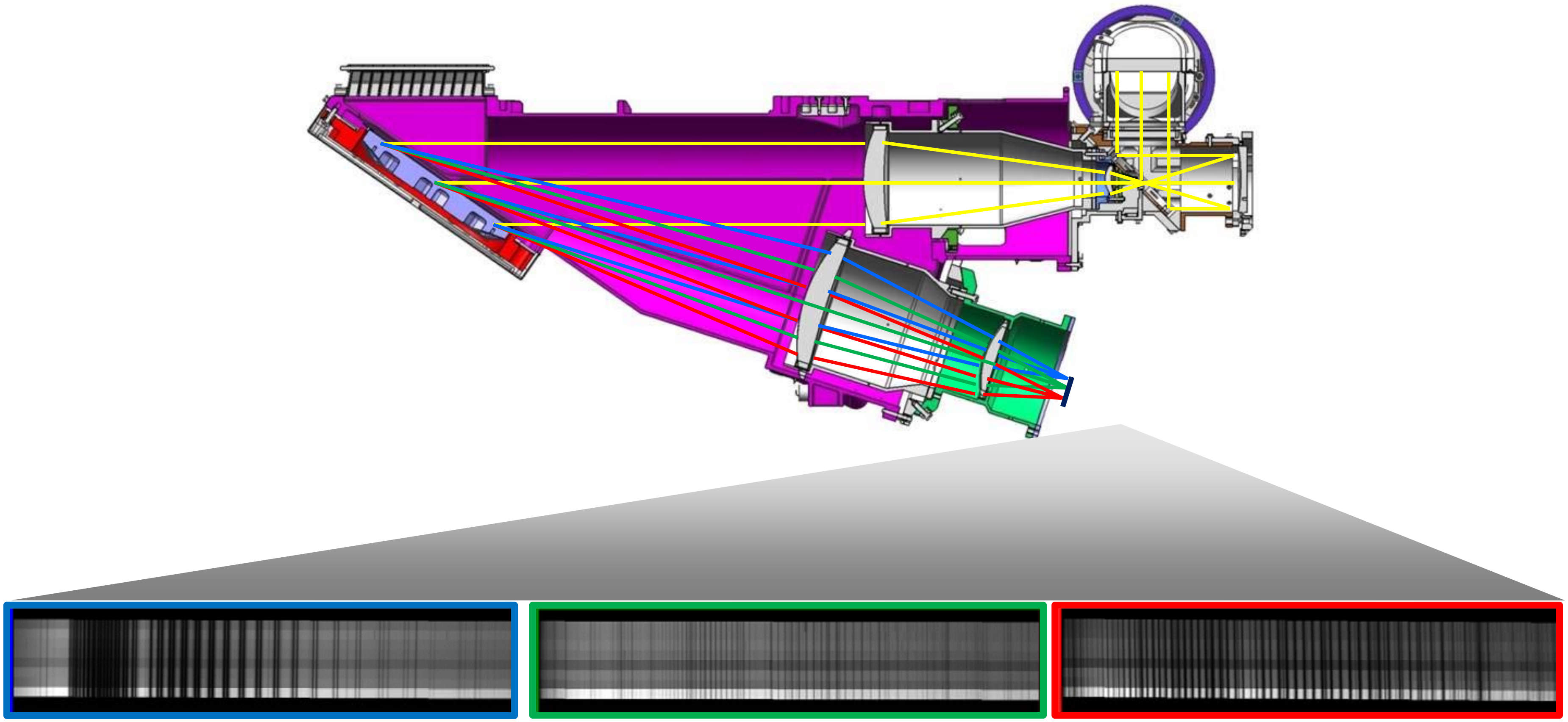
Joining the A-Train
3 August 2014

Joining the A-Train: August 3 2014



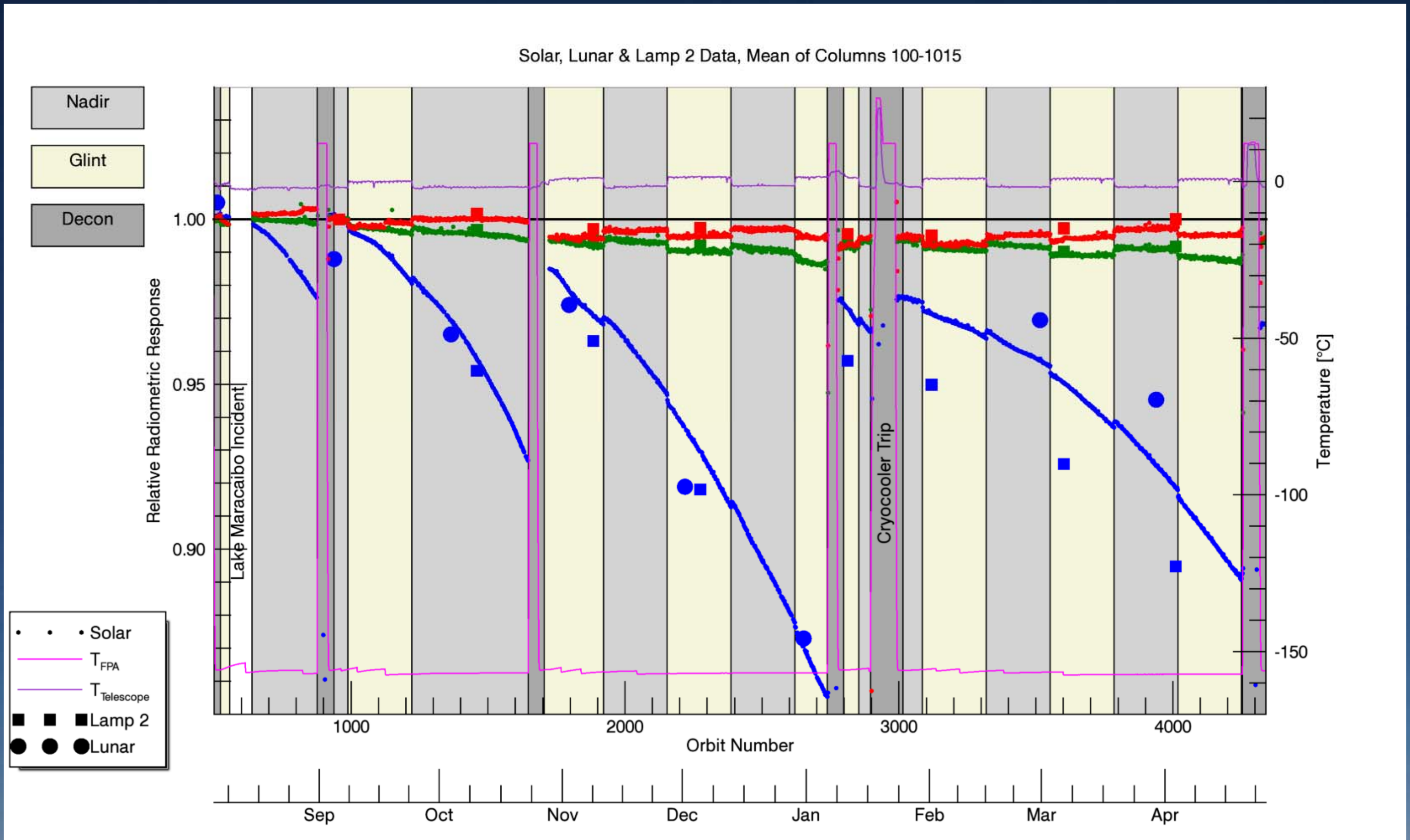
OCO-2 flies at the head of the 705-km Afternoon Constellation (A-Train)

The OCO Instrument – Optimized for Sensitivity



0.765μm O_2 A-Band | CO_2 1.61μm Band | CO_2 2.06 μm Band

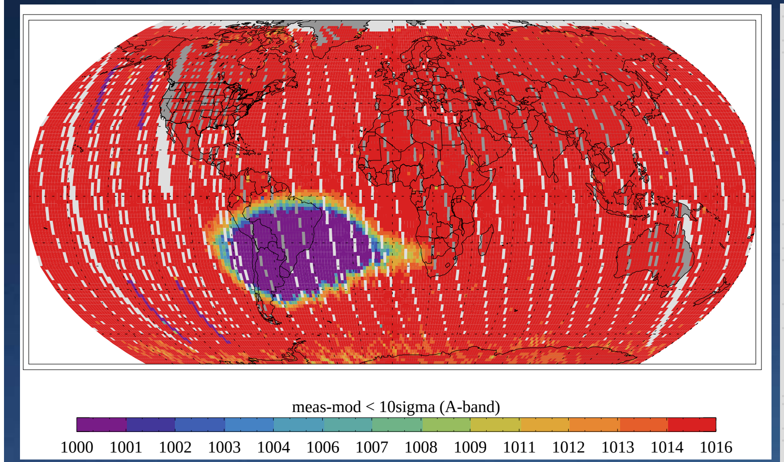
Calibration Challenges:
O_2 A-Band Sensitivity Changes

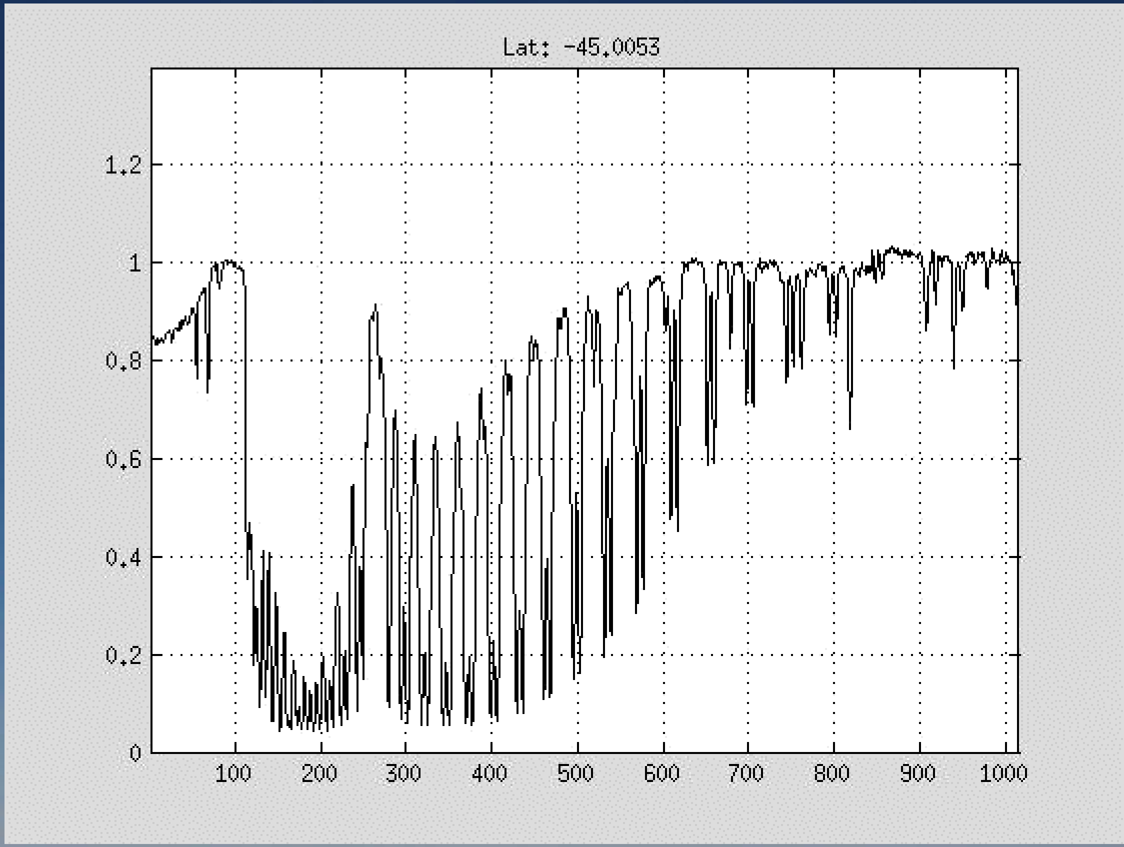


- January decontamination cycle substantially reduced rate of degradation
  - A decontamination cycle being conducted 20-30 April
- Root cause(s) of transient A-band sensitivity changes under investigation.

Calibration Challenges: Cosmic Rays

Cosmic rays a particular problem, especially on orbits that pass through the South Atlantic Anomaly (i.e. just about every orbit over South America)

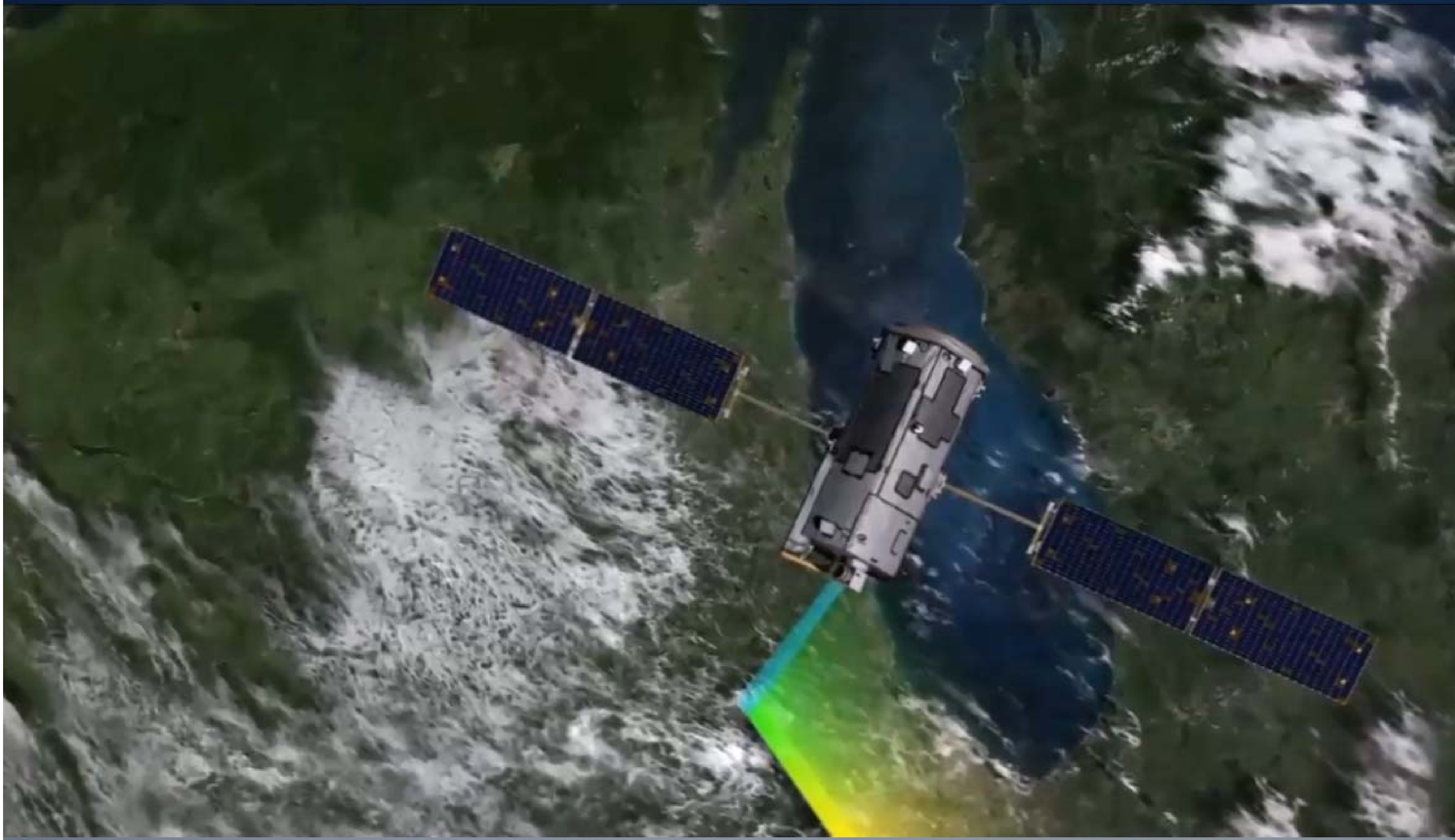




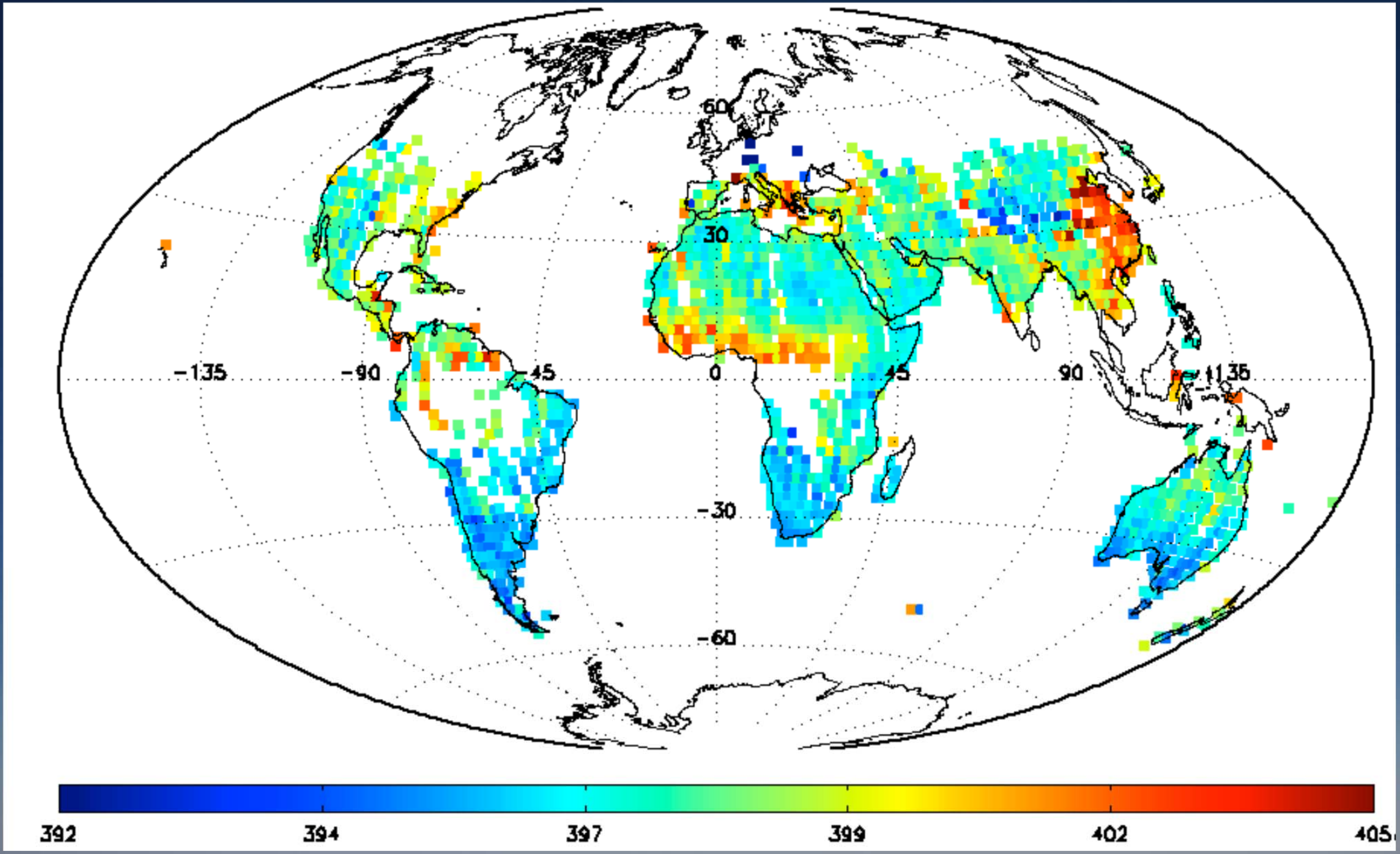
- The largest effects are seen in the O_2 A-band.
- An algorithm to screen the specific colors affected by cosmic rays has been implemented.

OCO-2 A-band spectra from the South Atlantic Anomaly

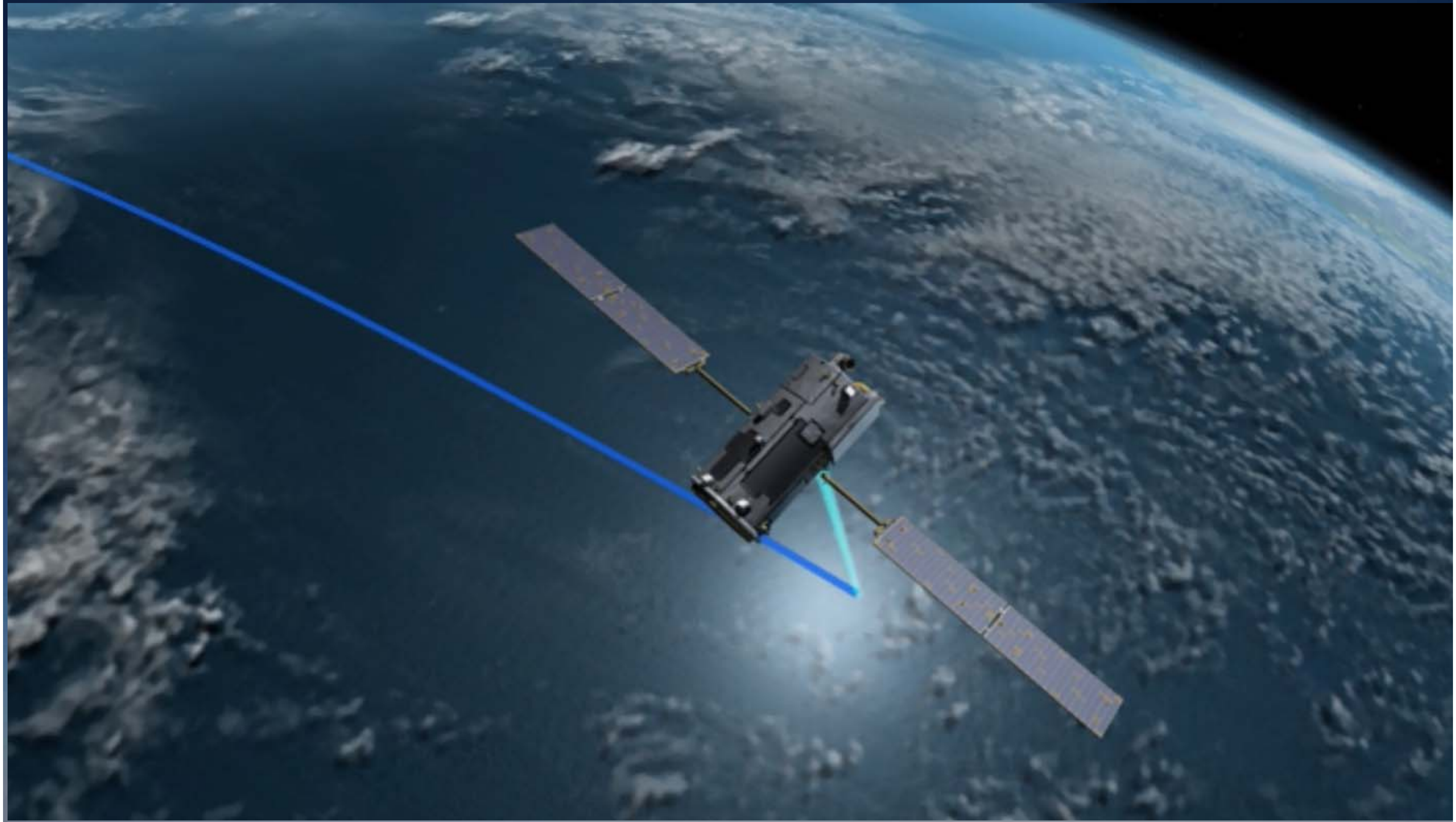
Nadir Observations



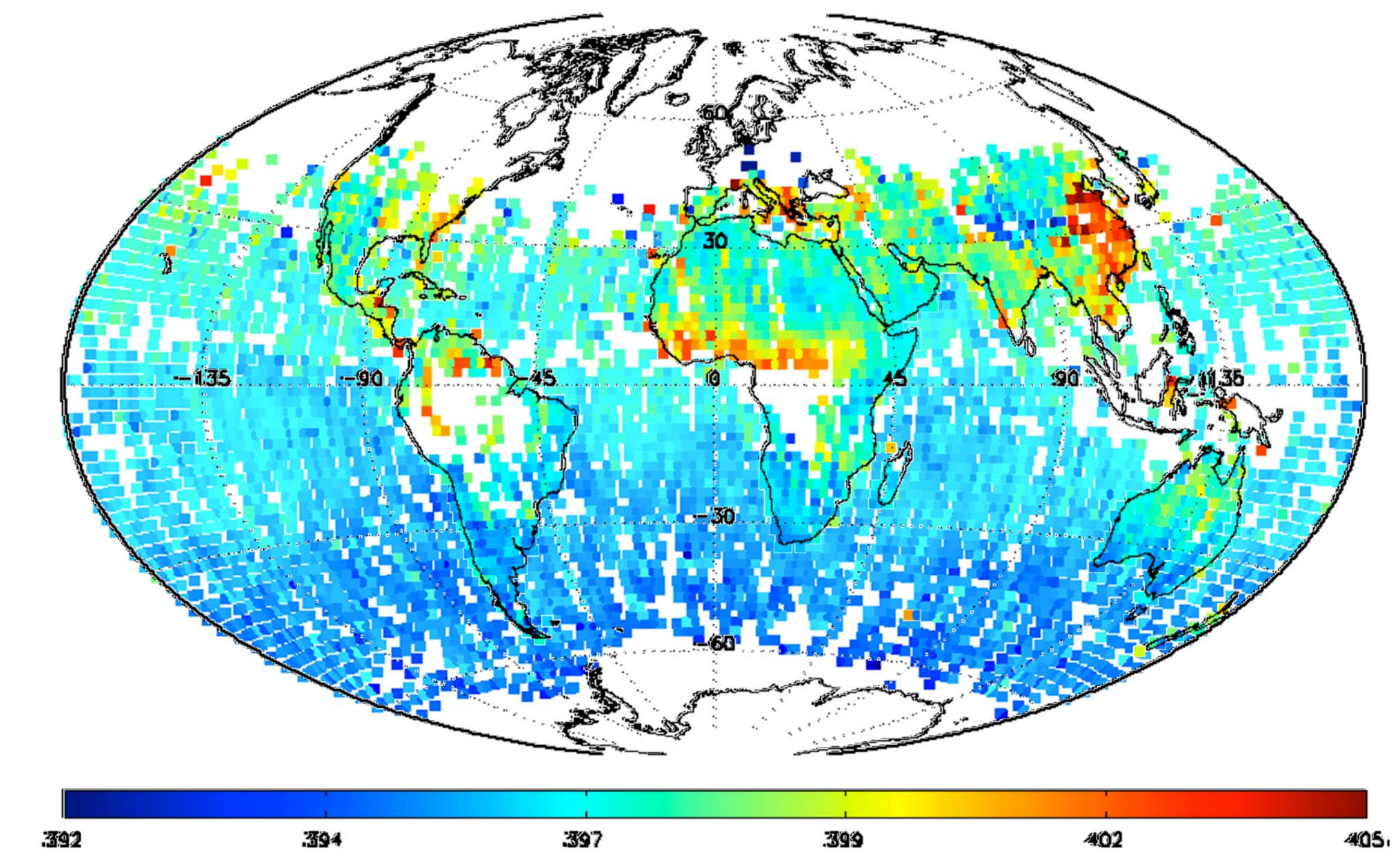
Preliminary Nadir Land X_{CO2} Estimates



Glint Observations

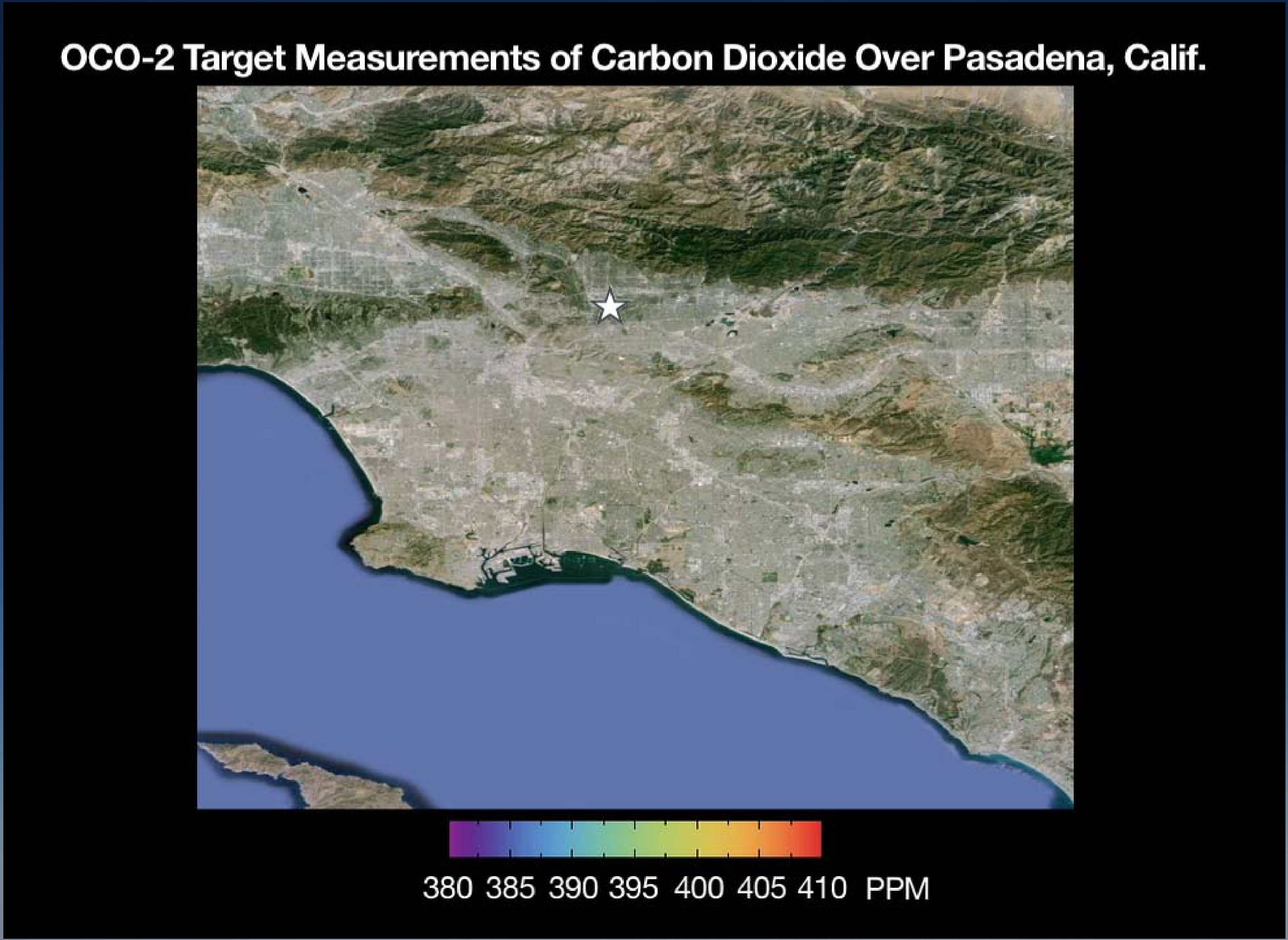


Preliminary X_{CO2} Estimates

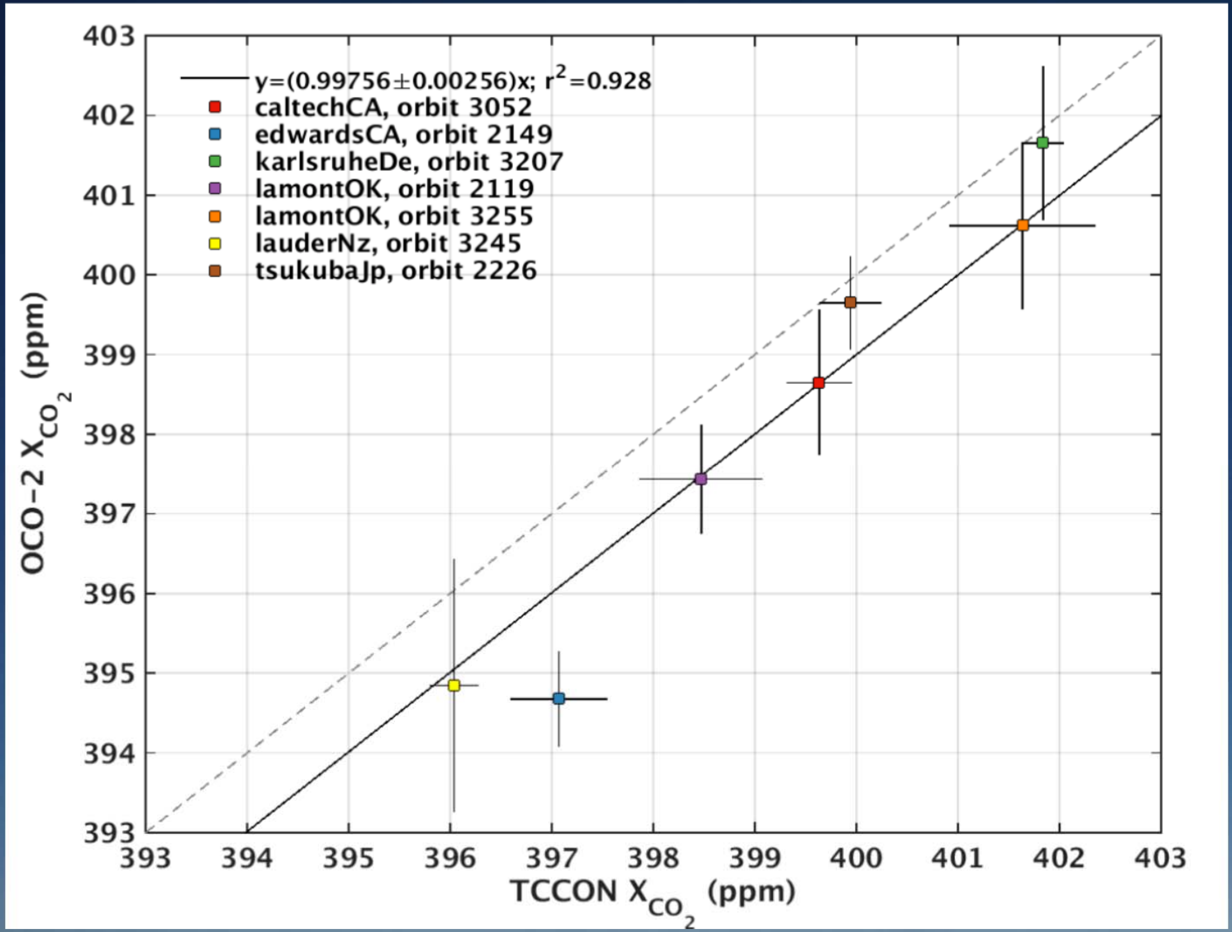


Target Observations

Validation: Targeting Total Carbon Column Observing Network (TCCON) Stations



Comparison of TCCON and OCO-2 X_{CO2}

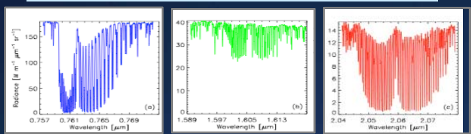


Comparisons with Total Carbon Column Observing Network (TCCON) stations are being used to identify and correct biases in target observations. *(Wunch et al.)*

Agreement with TCCON better the ~2 ppm (0.5%) and can be improved to ~1 ppm by correcting known biases.

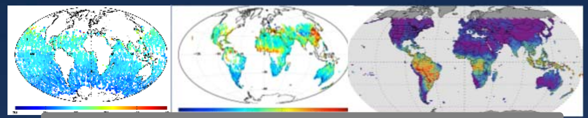
OCO-2 Data Product Delivery Schedule

L1B: Spectra



oco2_L1bScND_89220a_1009
- Dimensions
- FootprintGeometry
- FrameConfiguration
- FrameGeometry
- FrameHeader
- FrameTemperatures
- InstrumentHeader
- Metadata
- Shapes
- SliceMeasurements
- SoundingGeometry
- SoundingMeasurements

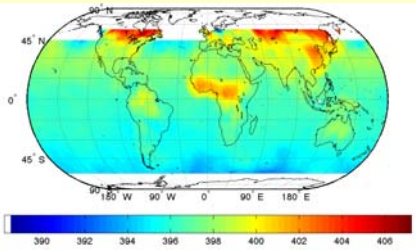
L2: XCO2, SIF, …



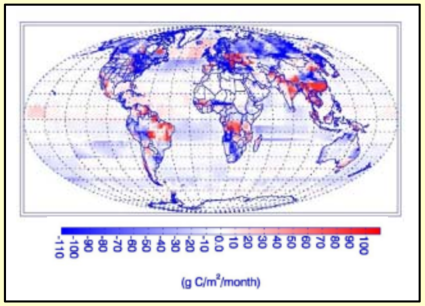
oco2_L2StdND_89220a_100923_
- AerosolResults
- AlbedoResults
- Dimensions
- DispersionResults
- L1bScSoundingReference
- Metadata
- PreprocessingResults
- RetrievalGeometry
- RetrievalHeader
- RetrievalResults
- Shapes
- SpectralParameters

Mapped Products

L3: X_{CO2} Maps



L4: Fluxes

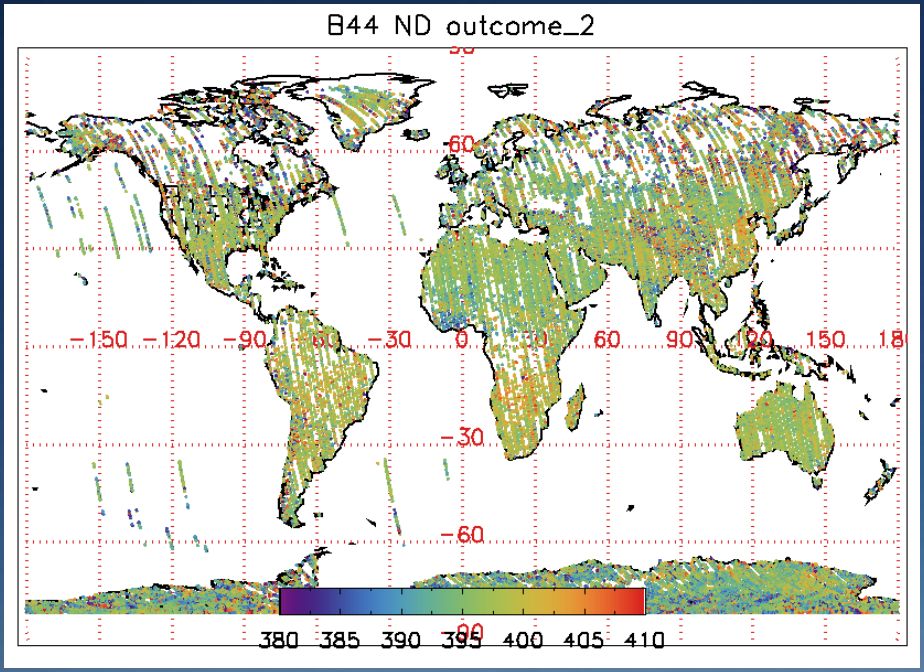


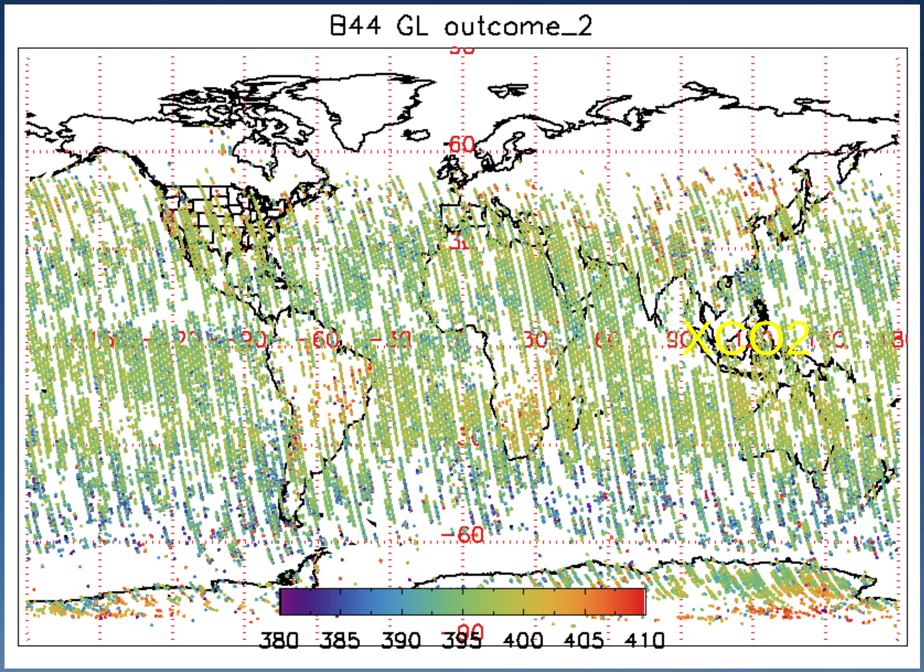
December 30, 2014 — **March 30, 2015** — **As Available**

http://disc.sci.gsfc.nasa.gov/datacollection/OCO2_L1B_Science_V5.html

Updating the Glint/Nadir Sampling Strategy

Changes in the OCO-2 glint/nadir sampling schedule are currently under consideration

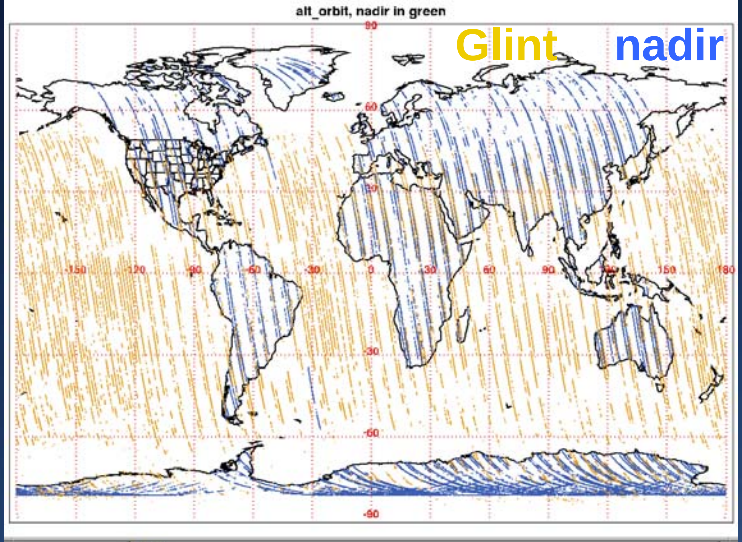


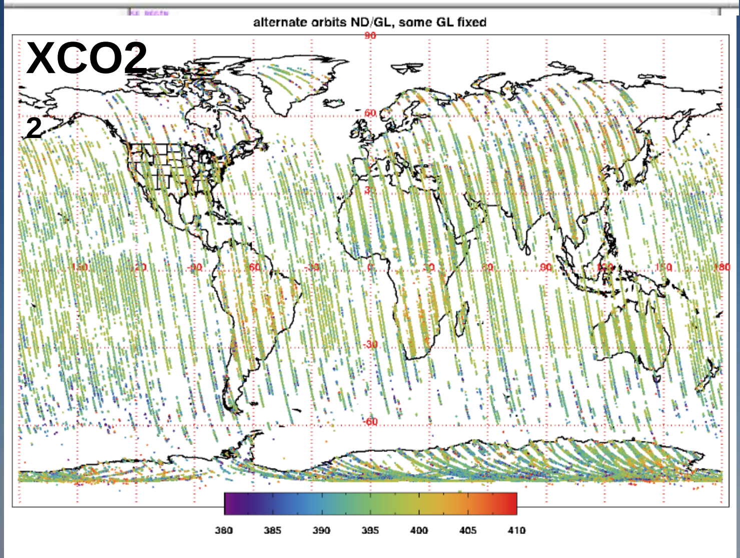


16 days like this …. **And then 16 days like this**

Leaves big gaps in ocean measurements. Land data impacted by nadir/glint sensitivity differences and latitude limitations

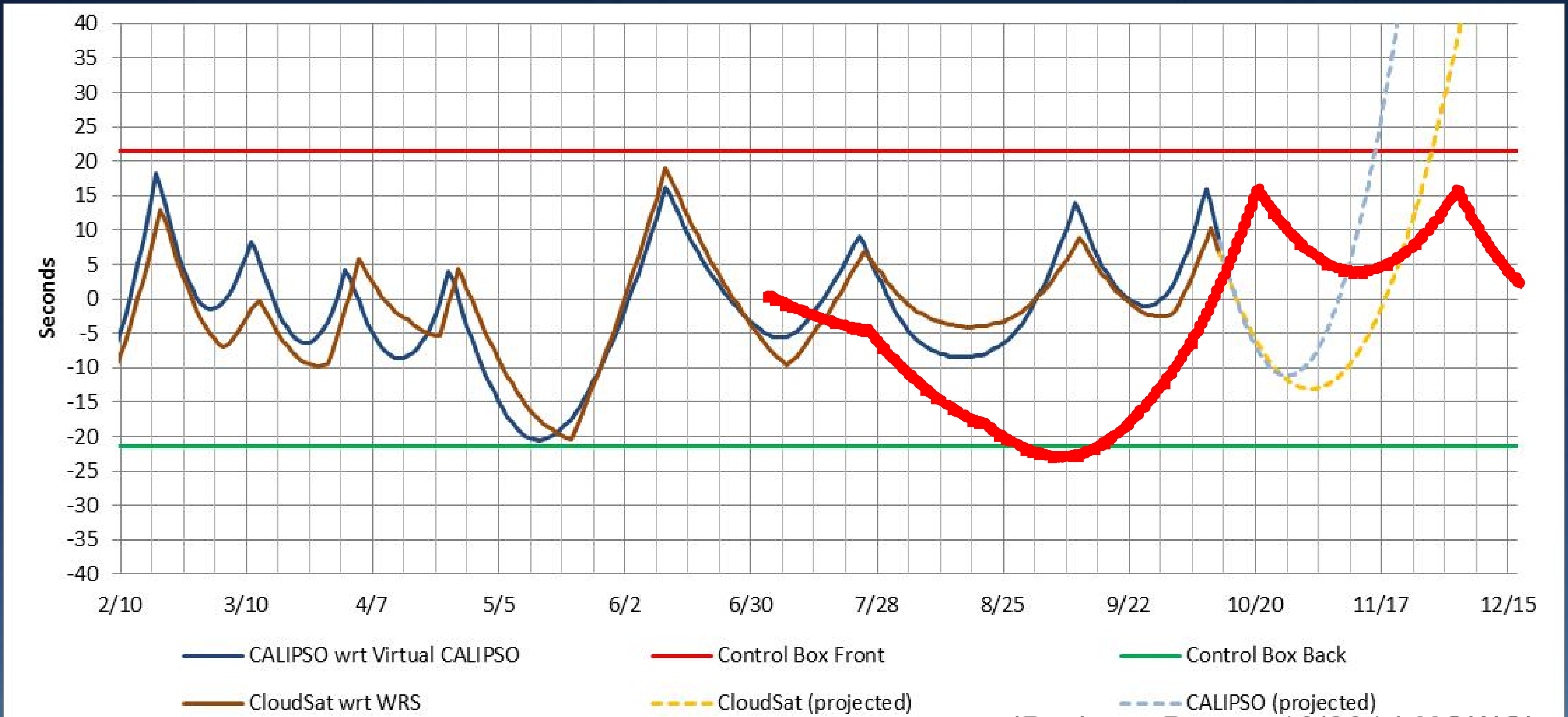
Alternate Nadir and Glint by Orbit





- A new glint strategy with alternating glint/nadir orbits:
  - Step 1: alternate between glint and nadir on successive orbits
  - Step 2: alternate between glint and nadir on successive orbits for orbits that include some land and some water, but stay in glint for orbits that are predominately over ocean
- This strategy increases the gaps between sampled areas for a single repeat cycle but fill in the gaps over a 32-day period.

Formation Flying for CloudSat, CALIPSO, and OCO-2



(Barbara Braun, 10/2014 MOWG)

- **CloudSat & CALIPSO stay within their control boxes and coordinate their maneuvers to align their surface footprints within 4 km of each other.**
- **OCO-2 has not yet started to coordinate it maneuvers.**

A-Train Coordination: Closer Formation Flying with CloudSat and CALIPSO

- OCO-2 must fly in a much tighter formation with CloudSAT and CALIPSO to maximize the overlap with their narrow swaths
- Combining OCO-2 nadir observations with CloudSat and CALIPSO cloud and aerosol measurements would benefit both missions
  - Cloud and aerosol optical depth and vertical distribution measurements from CloudSat and CALIPSO could be used to
    - Validate cloud screening & cloud/aerosol retrieval algorithms
    - Serve as a prior to initialize the cloud and aerosol retrievals.
  - OCO-2 cloud and aerosol measurements could be combined with CloudSat and CALIPSO measurements to more completely characterize the occurrence of thin, high clouds and their impact on the solar radiation budget.
    - A-Band spectrometers were included on both CloudSat and CALIPSO, but were descoped to control cost growth
    - The OCO-2 A-Band observations will help to address this need

Summary

- OCO-2 spacecraft operations are "NOMINAL"
  - Instrument conducted a decontamination cycle 20-30 April
- An updated L1b product is being delivered to GES-DISC for distribution to the science community (30 March).
- A preliminary L2 data product has been released (30 March).
  - Validation against TCCON and other standards is ongoing.
  - Updated documentation for the new products delivered
- Two changes in the operations strategy are being implemented:
  - Modify the Glint / Nadir scheduling to optimize coverage
  - Fly in a tighter formation with CloudSat and CALIPSO to maximize overlap of swaths

Thank You for Your Attention

Questions?